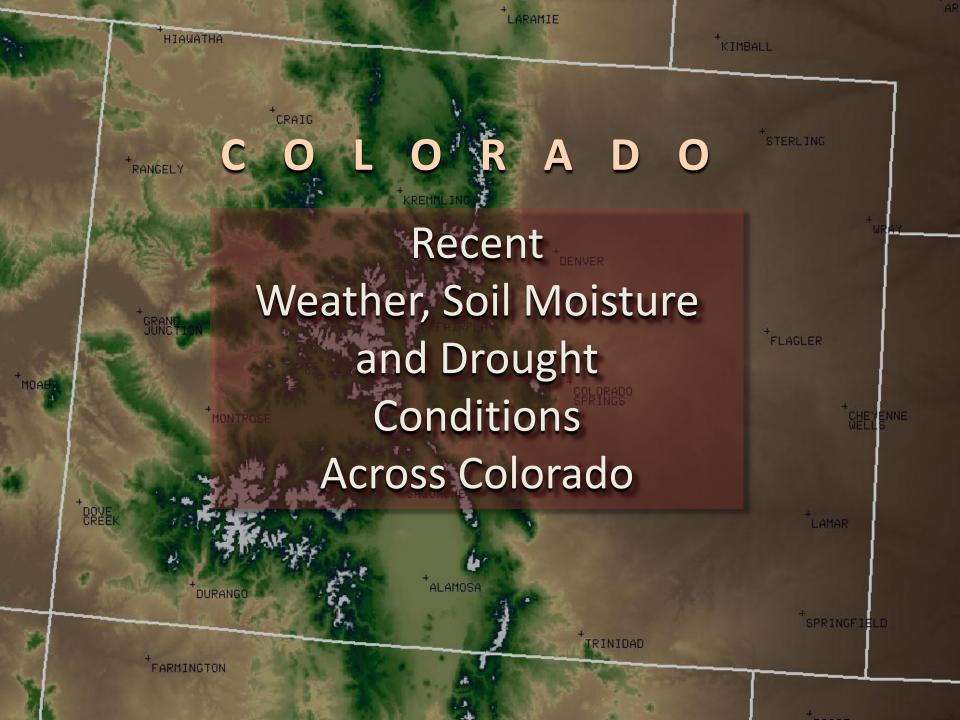
Recent Weather and Drought
Conditions,
the Latest on ENSO
and the
January-March 2013
Outlook
For Colorado

Mike Baker National Weather Service Boulder, Colorado December 22, 2012

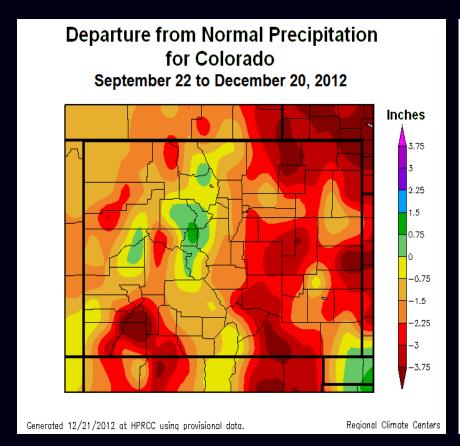


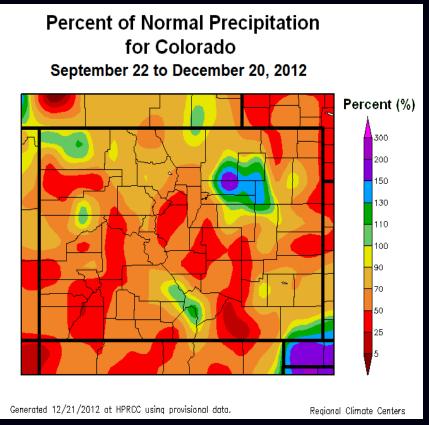






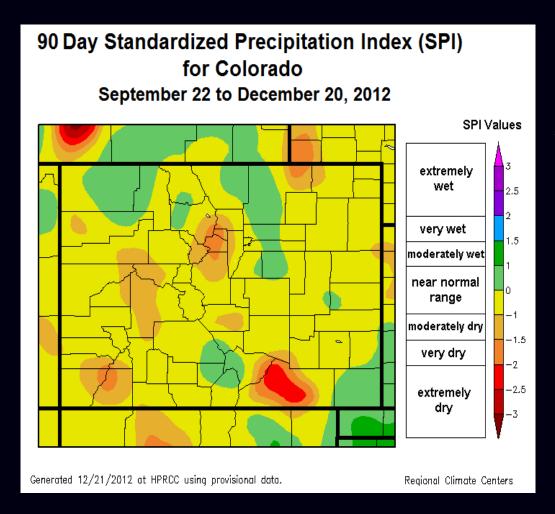
Precipitation for the 90-Day Period Ending December 20, 2012





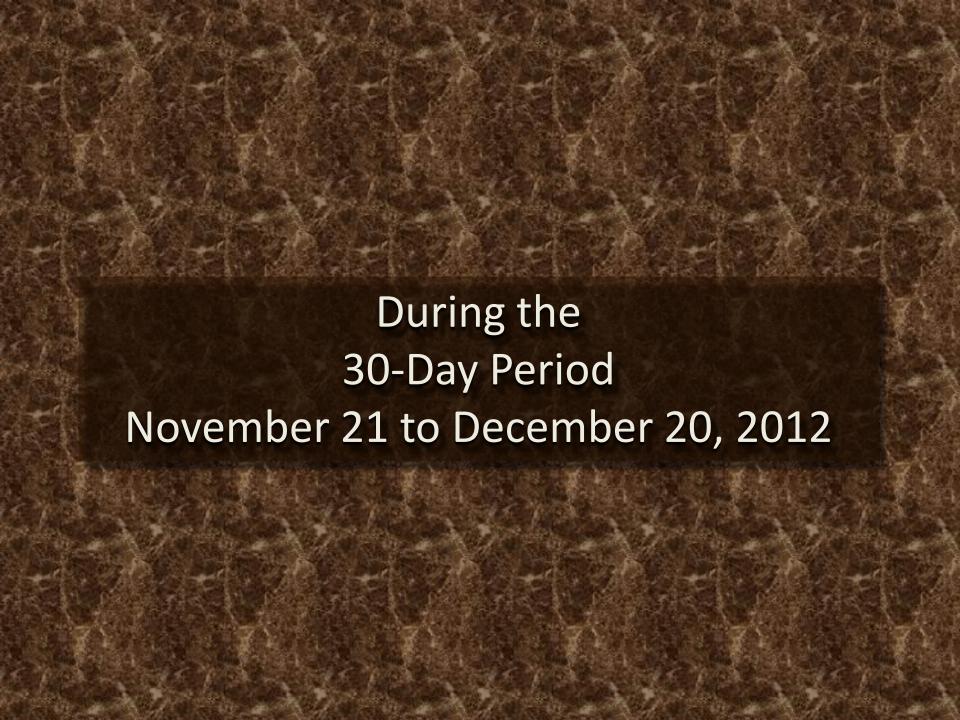
Other than scattered pockets of above to much above average precipitation east of Denver in northeast Colorado, in the extreme southeast corner of the state and on the west slope, precipitation overall during this recent 90-day period ranged from below to much below average across the Centennial State.

Soil Moisture Conditions for the 90-Day Period Ending December 20, 2012

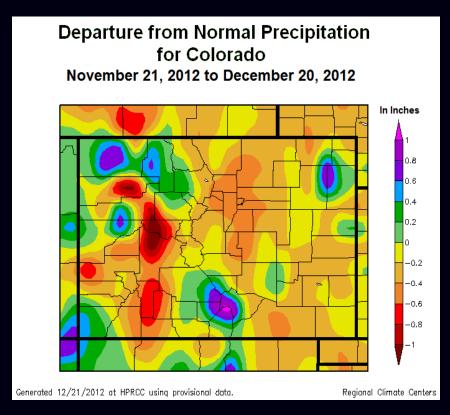


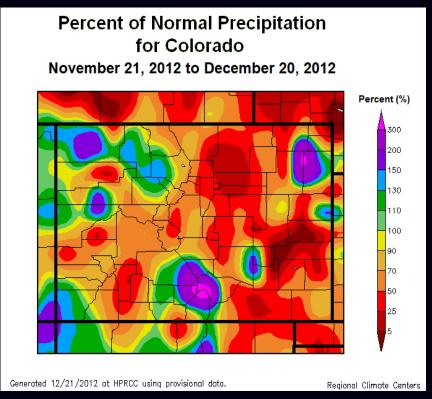
The Standardized Precipitation Index (SPI) during this 90-day period indicates near normal soil moisture conditions for most of the Colorado. Exceptions include the oblong area of extremely dry soil conditions along the east slope of the Sangre de Cristo mountain range in southeast Colorado and a scattering of moderate to very dry soils across western and extreme northeast Colorado.

The SPI was developed to monitor potential short term agricultural and long-term hydrological drought conditions. The SPI is a probability index that considers <u>only</u> precipitation.



Precipitation for the 30-Day Period Ending December 20, 2012

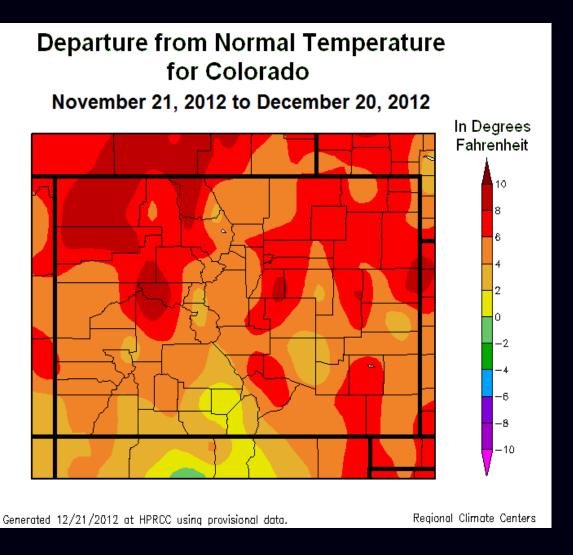




The above maps reveal a quilt work of above and below normal precipitation across Colorado during the recent 30-day period ending December 20, 2012. Overall, eastern Colorado continued to receive the least amount of precipitation, with a section of southeast Colorado receiving less than 5 percent of its normal allotment. At the same time, a few areas in eastern Colorado were fortunate to receive well over 150 percent of their seasonal average.

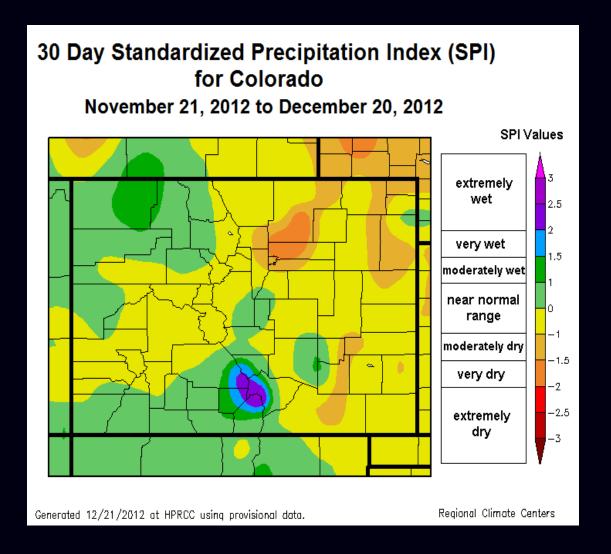
Western Colorado faired somewhat better, especially the northwest, the far southwest and south central parts of the state where a series of late autumn storms produced substantial precipitation in the form of snow. Precipitation in these areas ranged generally from 130 to around 300 percent of normal.

Temperature for the 30-Day Period Ending December 20, 2012



Temperatures across Colorado during the 30-day period ending December 20, 2012 continued to run above average. For the most part, temperatures across northern and eastern Colorado ranged from 4 to 10 degrees (F) above average, and from zero to 4 degrees (F) above average for the remainder of the state.

Soil Moisture Conditions for the 30-Day Period Ending December 20, 2012



The Standardized Precipitation Index (SPI) indicated near normal to moderately dry soil conditions in eastern Colorado, with the exception of an elongated area of very dry soils north and east of the Denver metropolitan area.

The SPI also indicated near normal to moderately wet soils across western Colorado, and a pocket of extremely wet soil conditions in and near the San Luis Valley in south central Colorado.

U.S. Drought Monitor

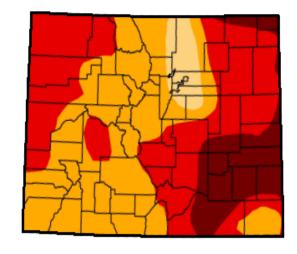
December 18, 2012

Valid 7 a.m. EST

Colorado

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	95.06	53.47	13.48
Last Week (12/11/2012 map)	0.00	100.00	100.00	95.06	53.43	13.48
3 Months Ago (09/18/2012 map)	0.00	100.00	100.00	100.00	61.75	16.89
Start of Calendar Year (12/27/2011 map)	67.79	32.21	24.98	14.94	0.04	0.00
Start of Water Year (09/25/2012 map)	0.00	100.00	100.00	100.00	61.75	16.89
One Year Ago (12/13/2011 map)	67.79	32.21	24.98	14.94	1.33	0.16



Intensity:







D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements at the website below.

http://droughtmonitor.unl.edu









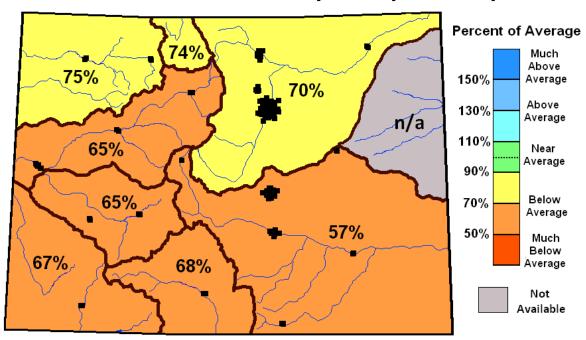
Released Thursday, December 20, 2012 Brian Fuchs, National Drought Mitigation Center

As of December 18, 2012, the U.S. Drought Monitor indicated extreme (D3) to exceptional (D4) drought conditions for much of eastern Colorado, and extreme drought conditions (D3) across the northwest corner of the state.

Furthermore, severe drought (D2) conditions were indicated across the southwest and along the spine of the Rocky Mountains. There was also an elongated area of moderate drought (D1) conditions on the state's northeast plains adjacent to the Front Range. This includes the greater Denver metropolitan area.



Colorado SNOTEL Snowpack Update Map



Snow Water Equivalent as a Percent of Average (%) for Colorado by River Basin as of Thursday Dec. 20, 2012

Basin Wide Percent of Average (%)

WEST SLOPE	EAST SLOPE
Yampa and White River Basins	Laramie & North Platte Basin
San Migual, Dolores, Animas & San Juan River Basins67% Upper Rio Grande Basin68%	Statewide Avg 68%

Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon provisional data, subject to revision

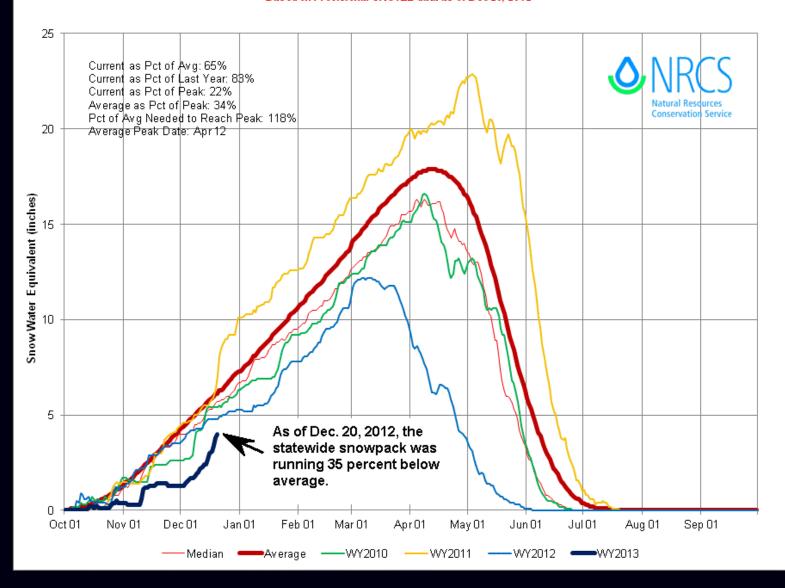
As of December 20, 2012, the Colorado snowpack continued to run below normal with a statewide average of 68 percent.

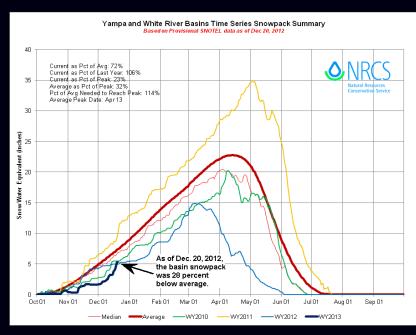
Northwest, southwest and south central portions of Colorado saw the greatest improvement in the snowpack, though not readily apparent from this map. A series of Pacific storm systems in late November and early December deposited a substantial amount of snow in these areas.

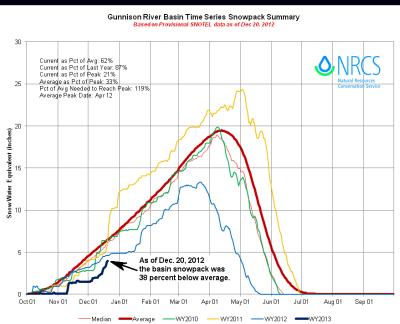
Meanwhile, the Arkansas River Basin in southeast Colorado continued to have the lowest average snowpack in the state.

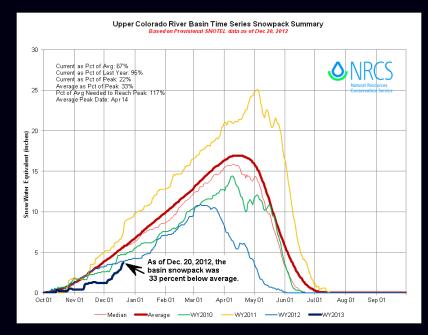
Colorado Statewide Time Series Snowpack Summary

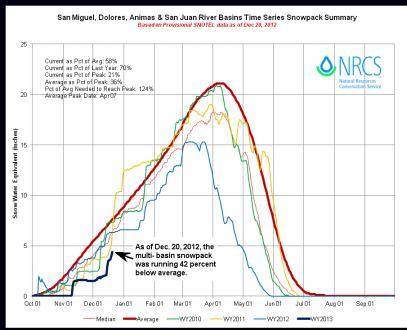
Based on Provisional SNOTEL data as of Dec 20, 2012

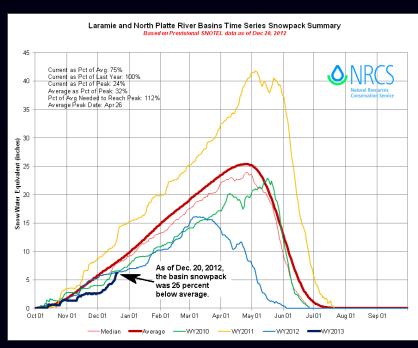


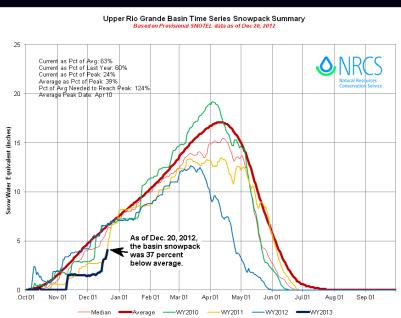


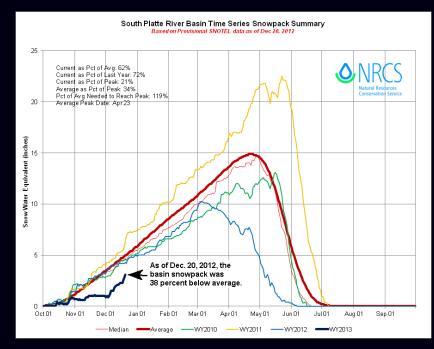


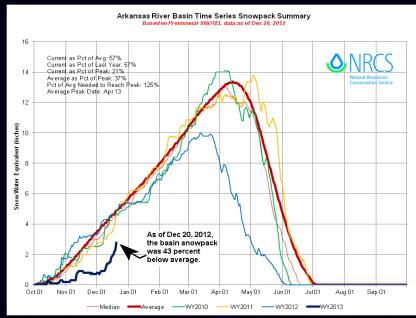




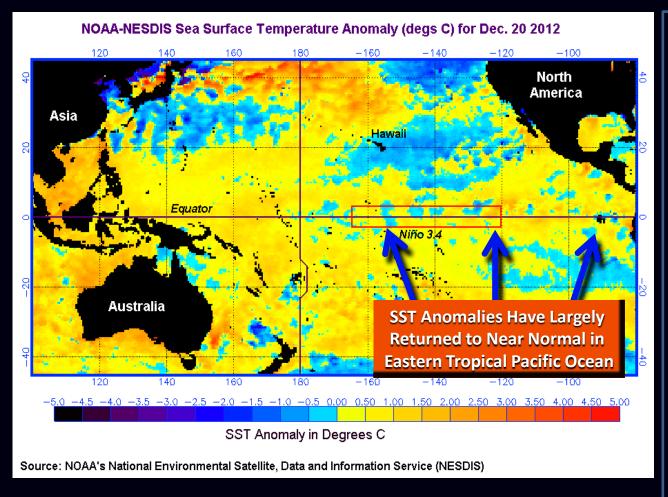








The Latest on ENSO



Niño 3.4 – The principal region in the eastern Equatorial Pacific Ocean (red outlined box along the equator) used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting the interseasonal climate phenomena called El Niño/Southern Oscillation (ENSO).

Slightly warmer than normal waters continue to dominate the Pacific Ocean the third week of December 2012.

However, in the past few weeks, positive sea surface temperature (SST) anomalies in the eastern tropical Pacific Ocean region known as Niño 3.4 have weakened (cooled), and in some areas, have become negative in value (colder than average).

The Oceanic Niño Index (ONI) for Niño 3.4

Year	DJF	JFM	FMA	MAM	АМЈ	МЈЈ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.5	-1.1	-0.9	-0.8	-0.7	-0.6	-0.5	-0.5	-0.6	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.3	-0.2	-0.1	0.0	0.0	-0.1	-0.2	-0.2	-0.3
2002	-0.2	0.0	0.1	0.3	0.5	0.7	0.8	0.8	0.9	1.2	1.3	1.3
2003	1.1	8.0	0.4	0.0	-0.2	-0.1	0.2	0.4	0.4	0.4	0.4	0.3
2004	0.3	0.2	0.1	0.1	0.1	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.4	0.3	0.3	0.3	0.3	0.2	0.1	0.0	-0.2	-0.5	-0.8
2006	-0.9	-0.7	-0.5	-0.3	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.0
2007	0.7	0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.6	-0.9	-1.1	-1.2	-1.4
2008	-1.5	-1.5	-1.2	-0.9	-0.7	-0.5	-0.3	-0.2	-0.1	-0.2	-0.4	-0.7
2009	-0.9	-0.8	-0.6	-0.2	0.1	0.4	0.5	0.6	0.7	1.0	1.4	1.6
2010	1.6	1.4	1.1	0.7	0.2	-0.3	-0.8	-1.2	-1.4	-1.5	-1.5	-1.5
2011	-1.4	-1.3	-1.0	-0.7	-0.4	-0.2	-0.2	-0.3	-0.6	-0.8	-1.0	-1.0
2012	-0.9	-0.7	-0.5	-0.3	-0.1	0.0	0.1	0.3	0.4	0.6		

NOAA/CPC Last Update 12-05-12

The ONI for the latest complete 3-month climate season (September-November) was +0.6; an increase of +0.2 from the previous overlapping 3-month season ASO.

El Niño : ONI higher than +0.45 Neutral ENSO : ONI of -0.45 to +0.45

La Niña: ONI lower than -0.45

The ONI is based on sea surface temperature (SST) departures from average in the Niño 3.4 region of the eastern tropical Pacific Ocean. It is the principal measure used by NOAA's Climate Prediction Center (CPC) for monitoring, assessing and predicting El Niño/Southern Oscillation (ENSO.)

ONI is defined as the three-month running mean SST departure in the Niño 3.4 region of the Pacific.

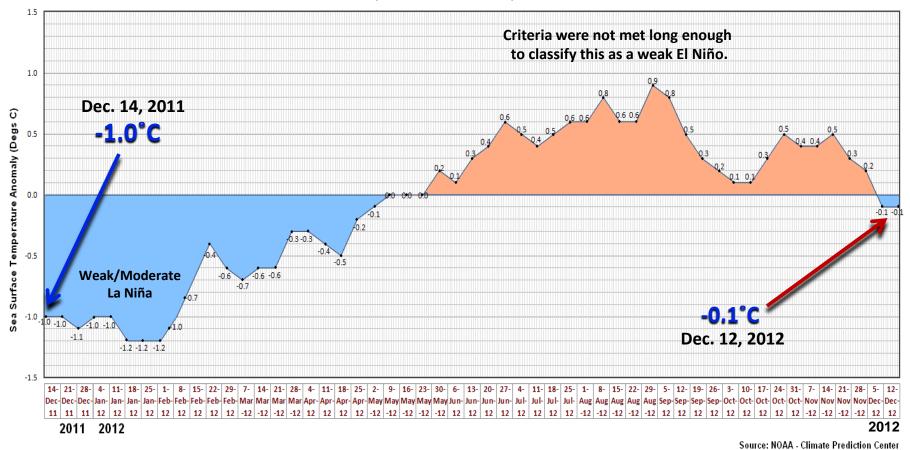
ONI is used to place current ENSO and non-ENSO events into a historical perspective.

CPC's operational definitions of El Niño and La Niña are keyed to the ONI index.

For historical purposes, warm and cold phases of ENSO (the red and blue colored numbers) are defined when the threshold is met for a minimum of 5 consecutive overlapping 3-month seasons.



December 14, 2011 to December 12, 2012



The weekly SST anomaly for ENSO 3.4 has trended negative (-0.1C) since the start of December 2012, after being in positive territory since late May of 2012.

Mid-Dec 2012 Plume of Model ENSO Predictions 3.0 Dynamical Model: NCEP CFSv2 2.5 NASA GMAO DYN AVG JMA STAT AVG SCRIPPS 2.0 LDEO CPC CON AUS/POAMA 1.5 **ECMWF** UKMO SST Anomaly (°C) KMA SNU 1.0 ESSIC ICM COLA ANOM 0.5 MetFRANCE JPN-FRCGC COLA C CSM3 0.0 CS-IRI-MM 4 GFDL CM2.1 -0.5 CMC CANSIP Statistical Model: CPC MRKOV -1.0CDC LIM CPC CA -1.5CPC CCA CSU CLIPB -2.0UBC NNET FSU REGR OBS FORECAST UCLA-TCD -2.5 JFM FMA MAM AMJ JJA SON MJJ JAS ASO 2012 2013

Forecast SST Anomalies (deg C) for the Eastern Pacific Region Niño 3.4

Seasons (2012-2013)	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO
Average, Dynamical Models	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Average, Statistical Models	0.2	0.2	0.1	0	-0.1	-0.1	-0.1	-0.2	-0.2
Average, All Models	0.2	0.1	0.1	0.1	0.1	0	0.1	0	0

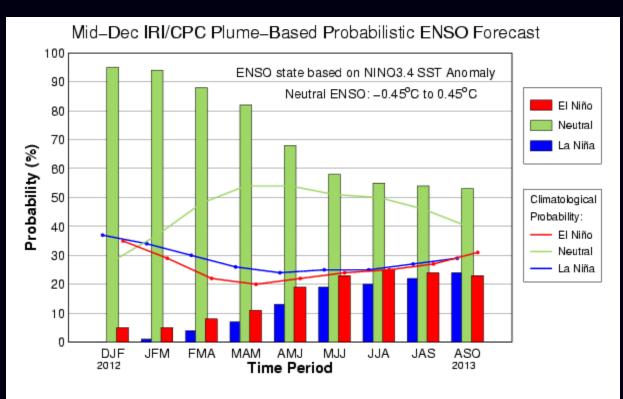
Source: The InternationI Research Institute for Climate and Society (IRI) - Dec 20 2012

The ENSO Outlook

An overwhelming majority of the dynamical and statistical climate models predict neutral or non-ENSO conditions in the Niño 3.4 region of the Pacific Ocean through the 2013 summer season.

The table in the lower left contains the cumulative average of sea surface temperature anomalies (SSTa) forecasted by 17 dynamical models and 8 statistical models, and a cumulative average for all 25 models for overlapping 3-month climate seasons ending August-September-October of 2013.

An SSTa value less than +0.45°C and greater than -0.45°C is a strong indicator of neutral ENSO conditions.



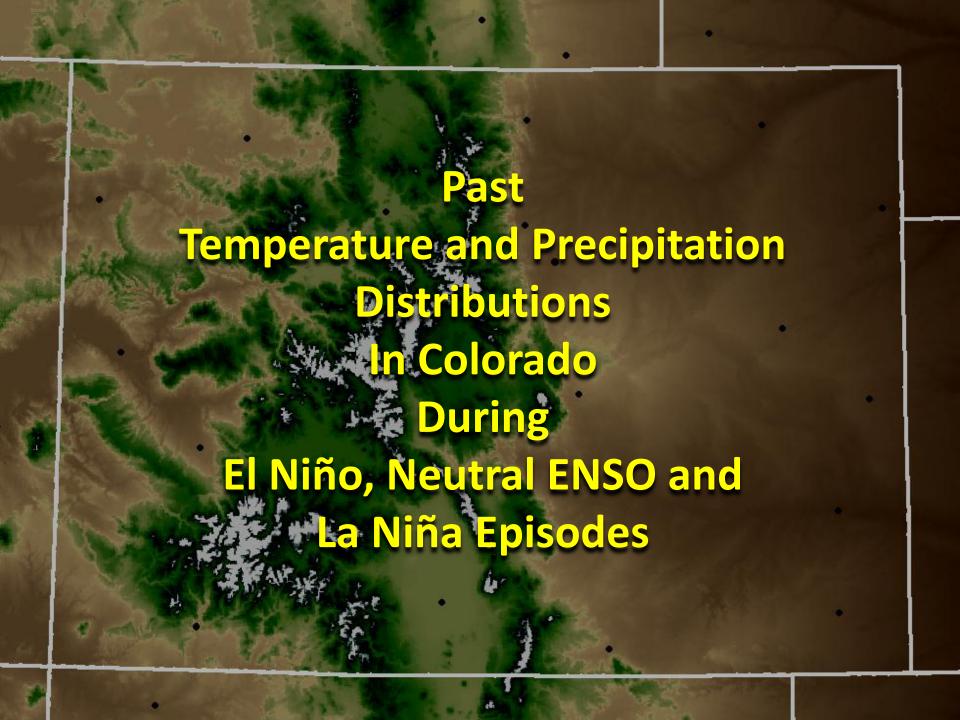
IRI Probabilistic ENSO Prediction for NINO3.4 Region

Season	La Niña	Neutral	El Niño
DJF 2012	~0%	95%	5%
JFM 2013	1%	94%	5%
FMA 2013	4%	88%	8%
MAM 2013	7%	82%	11%
AMJ 2013	13%	68%	19%
MJJ 2013	19%	58%	23%
JJA 2013	20%	55%	25%
JAS 2013	22%	54%	24%
ASO 2013	24%	53%	23%

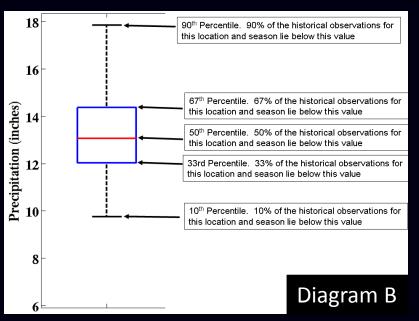
Probabilistic ENSO
Forecast for Nine
Overlapping 3Month Climate
Seasons Out
Through AugustOctober 2013

So, what weather patterns might we see across Colorado during the next few months with neutral ENSO conditions in the Pacific Ocean?

The following slides offer a reasonable answer to this question.



Colorado Climate Divisions Northeast Colorado Div. 046 Southeast Colorado Div. 047 Div. 099 Diagram A



Interpreting ENSO Box and Whisker Plots

Diagram A is a map of the four climate mega-divisions in Colorado used by the Climate Prediction Center (CPC)—Divisions 046, 047,048 and 099.

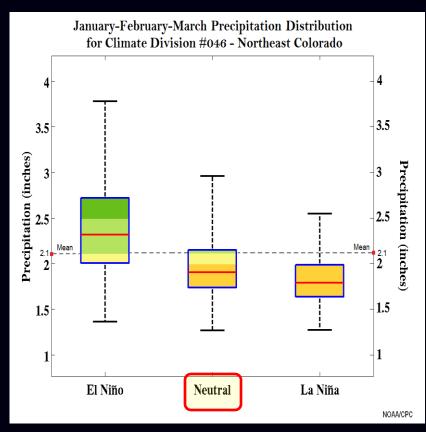
CPC has produced 3-month historical temperature and precipitation distribution plots for the three different ENSO categories –El Niño, La Niña and ENSO-neutral (non-ENSO) conditions for every climate mega-division in the United States.

Diagram B is a description of the ENSO box and whisker analysis plot used by CPC to represent historical temperature and precipitation distributions for each ENSO category pertaining to each climate division.

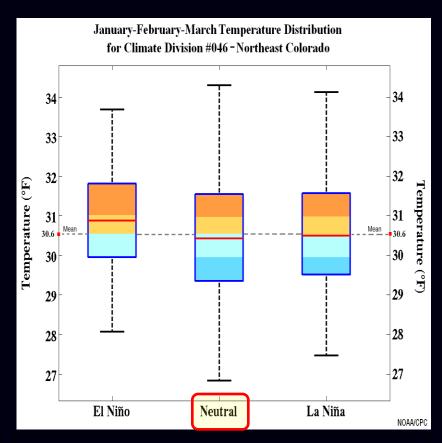
The red line inside the ENSO box represents the mean or 50th percentile of the data (temperature or precipitation) distribution for each climate division. Approximately 34% of the total observations exist within the ENSO box, and the remaining observations (about 66%) lie outside of the box along the whiskers extending above and below the box.

It should be pointed out that the following temperature and precipitation distributions do not differentiate between El Niño and La Niña events of weak, moderate and strong intensity.

Precipitation and Temperature Composites (ENSO Box and Whisker Analysis Plots) for the Northeast Colorado Climate Division #046 for January-March

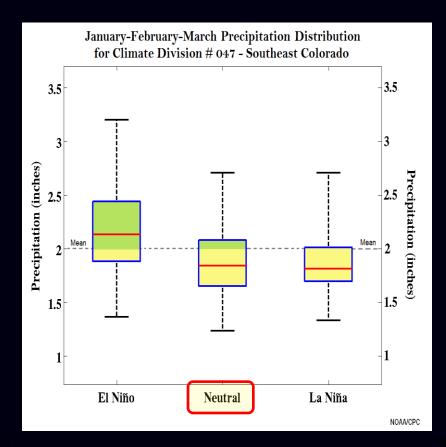


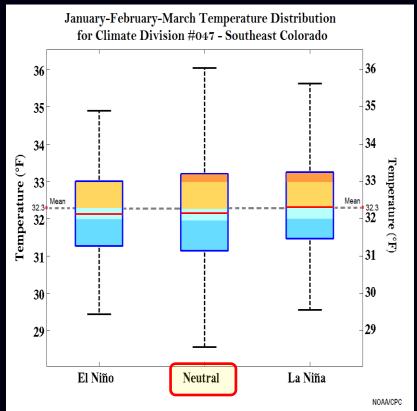
Precipitation in northeast Colorado during January through March historically has been near to below average during neutral or non-ENSO conditions, above average during El Niño events, and below average during La Niña episodes.



For the same three month period, temperatures have been *near average during neutral conditions* and La Niña events, and near to above average during El Niño events.

Precipitation and Temperature Composites (ENSO Box and Whisker Analysis Plots) for the Southeast Colorado Climate Division #047 for January-March

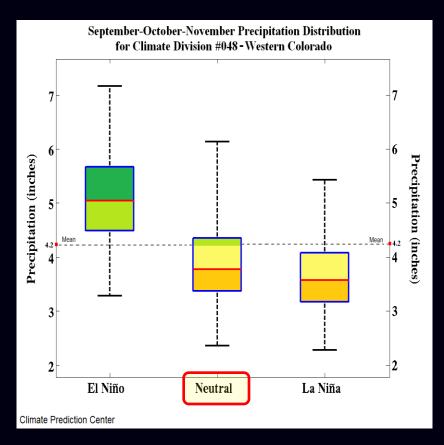


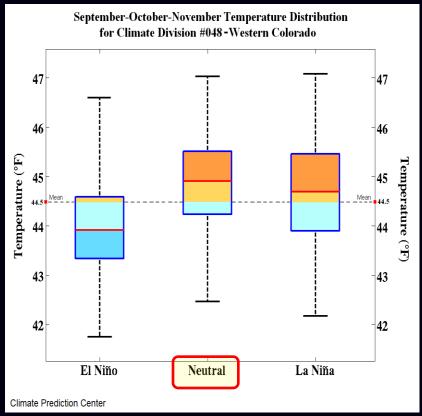


Precipitation in southeast Colorado during the climate season January through March historically has been *near to below average* during neutral conditions and La Niña periods, and near to above average during El Niño events.

For the same three month period, temperatures have been *near average during neutral ENSO*, El Niño and La Niña cycles.

Precipitation and Temperature Composites (ENSO Box and Whisker Analysis Plots) for the Western Colorado Climate Division #048 for January-March

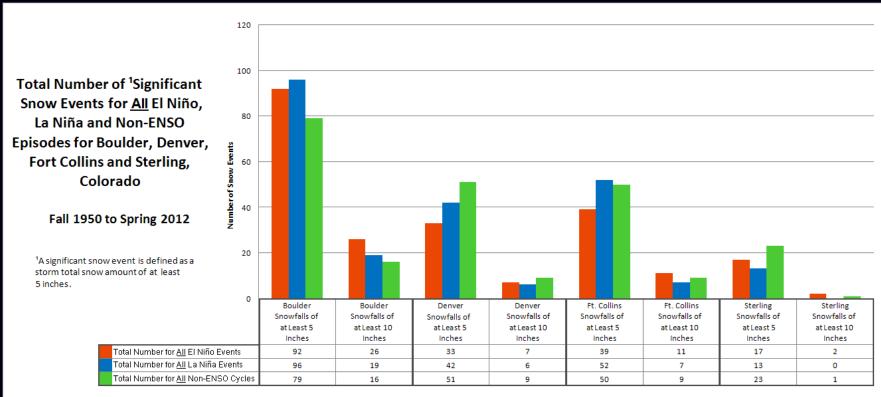




Precipitation across western Colorado historically has been *near to below average during neutral conditions*, above average during El Niños, and below average during La Niña events.

Finally, temperatures during the same three month period have been *near to above* average during neutral ENSO and La Niña episodes, and near to below average during El Niño events.

Prospects For Significant Snowfall in Northeast Colorado



Baker NWS Boulder

The majority of snow events of at least 5 inches in Boulder and Fort Collins happened during La Niña episodes. Denver and Sterling on the other hand, saw most of their 5 plus inch snowfalls during non-ENSO or neutral cycles.

Boulder, Fort Collins and Sterling saw most of their 10 plus inch snowfalls during El Niño events. While Denver saw most of its 10 plus inch snowfalls during non-ENSO periods.



6.00 5.00 **Average Number of** ¹Significant Snow Events 4.00 Average Number of Snowfall Events Per El Niño, La Niña and Non-ENSO Episode for 3.00 **Boulder, Denver, Fort Collins** and Sterling, Colorado 2.00 Fall 1950 to Spring 2012 1.00 ¹A significant snow event is defined as a storm total snow amount of at least 0.00 Average Average Average Average Average Average Average Average 5 inches. Number of Snowfalls of at Least 10 at Least 5 Inches in Inches in Inches in Inches in Inches in Fort Inches in Fort Inches in Inches in Collins Boulder Boulder Denver Denver Collins Sterling Sterling

1.94

1.91

1.89

0.41

0.27

0.39

2.29

2.36

2.17

0.32

The relationship between El Niño, La Niña and non-ENSO or neutral conditions and ¹significant snow events in Boulder, Denver, Fort Collins and Sterling, Colorado may also be shown by referencing the *average number* of significant snow events *per* ENSO and non-ENSO episode (see values in the above table).

5.41

4.36

3.43

1.53

0.86

0.70

Per El Niño Event

Per La Niña Event

Per Non-ENSO Cycle

From 1950 to the spring of 2012, El Niño events individually averaged the greatest number of 5 and 10 inch snowfalls in Boulder. For Denver, the difference in the average number of 5 plus and 10 plus inch snowfalls per El Niño, La Niña and non-ENSO episode was quite small. For Fort Collins, La Niña events individually averaged the greatest number of 5 plus inch snowfalls, and El Niño events singularly the most 10 plus inch snowfalls. Finally, the average number of 5 plus inch snowfalls in Sterling was evenly split between El Niño and non-ENSO periods, while the average number of 10 plus inch snowfalls per ENSO and non-ENSO event was too small to be considered relevant.



1.00

0.59

0.00

Baker - National Weather Service Boulder, Colorado

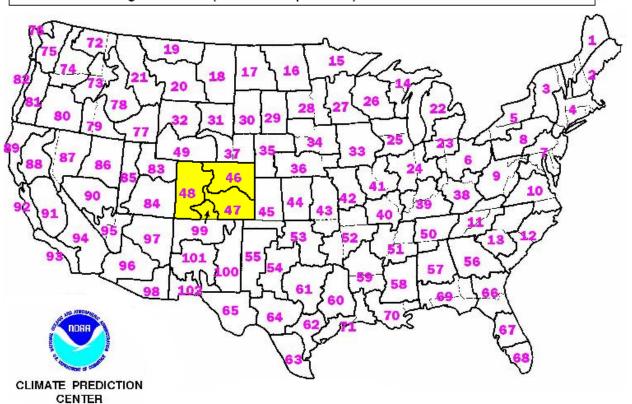
January-February-March
2013
Temperature and Precipitation
Outlooks for Colorado
Issued by the
Climate Prediction Center

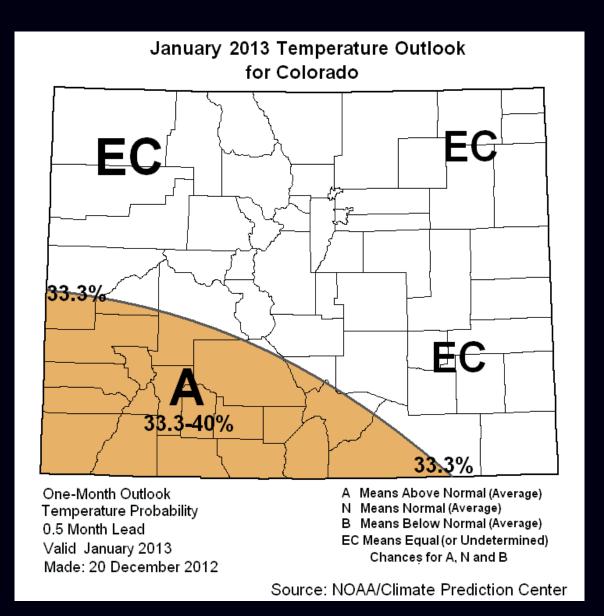
Climate Prediction Center Seasonal Outlooks

The National Weather Service Seasonal Climate Outlooks predict the probability of conditions being among the warmest/coldest or wettest/driest terciles of years compared to the period of record 1981-2010.

The outlooks indicate probability of being in three specific categories in reference to the 30-year climatology from 1981-2010. They are above, below and average.

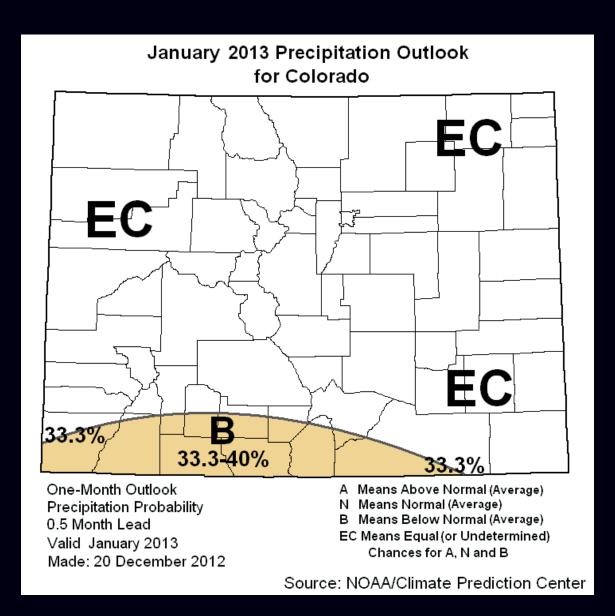
Remember, Climate Predicition Center (CPC) outlooks are made at the scale of the climate megadividions (see the map below).





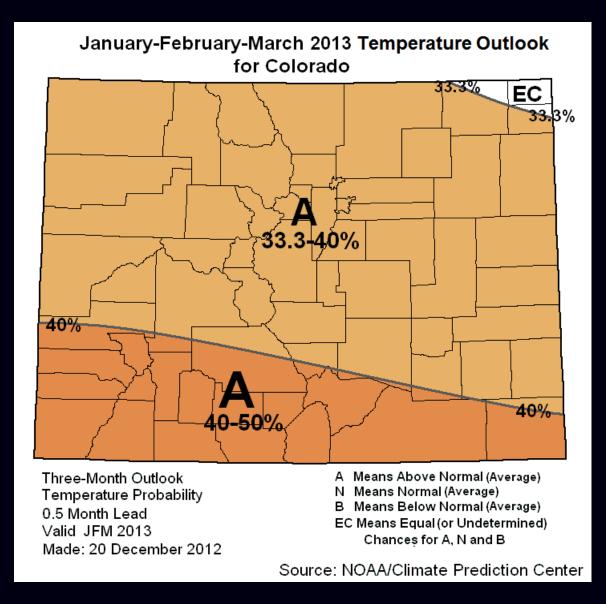
January 2013 Temperature Outlook for Colorado

NOAA's Climate Prediction Center (CPC) is predicting a 33.3 to 40 percent chance of above average temperature across the southwest corner of Colorado, and an equal or undeterminable chance (EC) for above, below and near average temperature for the remainder of Colorado during January 2013.



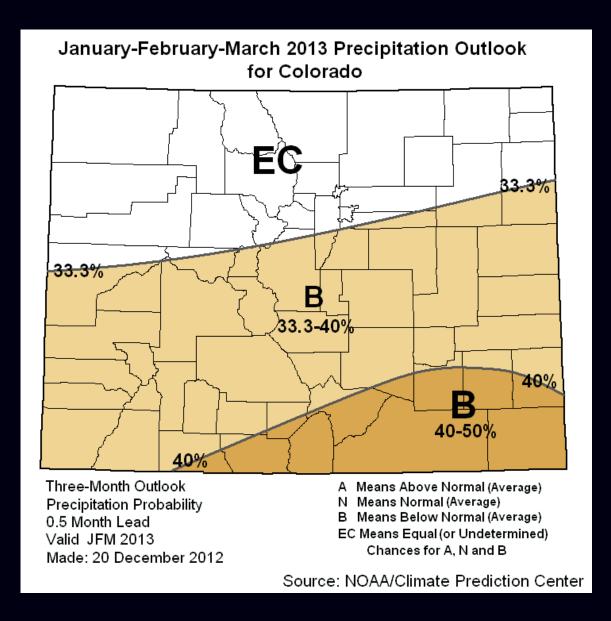
January 2013 Precipitation Outlook for Colorado

CPC is calling for an equal or undeterminable chance (EC) for above, below and near average precipitation for all of Colorado during January 2013, except for the far southwest border region of the state where there is a 33.3 to 40 percent chance of below average precipitation.



January-March 2013 Temperature Outlook for Colorado

For the climate season January through March of 2013, CPC is calling for a 40 to 50 percent chance of above average temperature across roughly the southern one-forth of Colorado, and except for a small area of EC in the far northeast corner, there is a 33.3 to 40 percent chance of above average temperature for the remainder of Colorado.



January-March 2012 Precipitation Outlook for Colorado

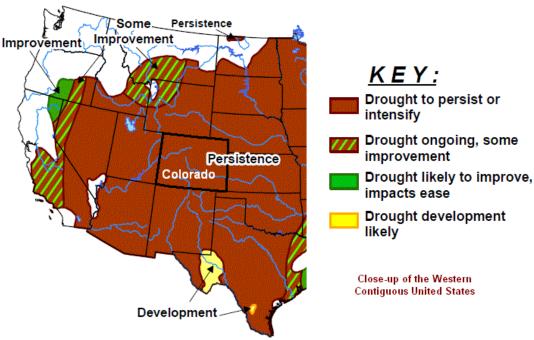
The precipitation outlook for this three month period calls for a 40 to 50 percent chance of below average precipitation across the southeast corner of Colorado and a 33.3 to 40 percent chance of below average precipitation central portions of the state. The latest outlook is also calling for an equal or undeterminable chance (EC) of above, below and near average precipitation for the northern third of Colorado.



U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period Valid for December 20, 2012 - March 31, 2013



Released December 20, 2012



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels. but do not necessarily imply drought elimination.

Finally, the latest seasonal drought outlook for the period valid from December 20, 2012 to March 31, 2013 calls for drought conditions to continue and possibly intensify across nearly all in the western United States, including Colorado.

For an outlook for the entire U.S., go to www.cpc.ncep.noaa.gov/products/expert assessment/season drought.gif.

Summing It Up

- Precipitation across Colorado for much of this autumn varied from below to much below average in eastern and southwestern sections of the state, to above and much above average in portions of northwest and north central Colorado. The state's snowpack has also suffered because of a severe lack of precipitation during October and early November.
- However in recent weeks, a series of Pacific storm systems managed to deposit a substantial amount of snow in a relatively short period of time on portions of southwest, south central and northwest Colorado. Average temperatures across Colorado have remained above average this fall, in some sections as much as 10 degrees (F) above average. The warmest temperature readings were generally recorded across northern sections of the state. The lack of precipitation and the unseasonably warm temperatures have contributed to the ongoing drought, as well as further reduce soil moistures in many parts of the state.
 - An overwhelming majority of the ENSO-climate models now indicate neutral ENSO (non-ENSO) conditions in the Pacific Ocean through the summer of 2013, and perhaps even beyond that.

Continued...

- During previous neutral ENSO/non-ENSO cycles, Colorado overall saw temperature and
 precipitation near to slightly above average, of course there were exceptions. No one part
 of the state can lay claim to a persistent precipitation pattern during neutral ENSO cycles
 as often occurs during El Niño and La Niña cycles. One storm may favor southwestern
 Colorado with heavy snowfall and strong winds, the next one the same wintery mix in the
 mountains and high valleys of northwest and central Colorado. Eastern Colorado would
 still see its share of winter storms during neutral ENSO periods, even though most of these
 storms would deposit the bulk of their moisture on the windward mountain slopes of
 western Colorado.
- The latest outlook for January from the Climate Prediction Center calls for a 33.3 to 40 percent chance of above average temperature and precipitation across southwest Colorado, and an equal or undeterminable chance of above, below and near average temperature and precipitation for the remainder of the state. For the third month season of January, February and March, the outlook calls for a 33.3 to 50 percent chance of above average temperature for nearly all of Colorado, and at least a 33.3 percent chance of below average precipitation for the southeastern two-thirds of the state. Lastly, drought conditions in Colorado are predicted to persist and possibly intensify through the spring of 2013.